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OPERATING EXPERIENCE SUMMARY

Office of Environment, Safety and Health

Summary 2001-02

The Office of Environment, Safety and Health (EH) publishes the Operating Experience Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and, time permitting, conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, 301-903-1845, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction.

The OE Summary can be used as a DOE-wide information source as described in Section 5.1.2, DOE-STD-7501-99, *The DOE Corporate Lessons Learned Program*. Readers are cautioned that review of the Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

Operating Experience Summary 2001-02

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EVENTS

1. FORKLIFT OPERATION INJURES WORKER

On March 15, 2001, a 900-pound steel frame fell from a forklift at the East Tennessee Technology Park Building K-31, causing a cut and contusion on a nearby worker's head near the temple. This is one of an extensive series of injuries and near misses occurring during forklift operations across the DOE complex. (ORPS Report ORO--BNFL-K31-2001-0001)

An experienced forklift operator was moving two large steel channel frames. He loaded each on a forklift tine, but tied down neither. The operator lifted the frames a short distance and backed out slowly, but stopped and reversed his direction to allow another forklift to pass. This latter motion caused one of the frames to topple and injure a nearby worker. The worker tried to avoid contact with the falling frame, but pallets blocked his movement. The onsite medical staff sutured, bandaged, and iced the worker's cut and observed him for signs of concussion before releasing him to return to work.

The contractor's initial investigation identified several causes related to poor work planning: 1) unstable positioning of a hazardous load; 2) workers too close to the hazardous load; 3) forklift rights-of-way not established or understood; and 4) poor communication between the forklift operator and workers. As a corrective action, the contractor briefed all work crews on the contents of two Safety Notes related to forklift right-of-way and safety near a load. The contractor is also reviewing and revising Enhanced Work Plans to better address hazard controls for load stabilization and work area control.

Six ORPS reports from the past two years noted forklift operations that resulted in personal injuries. Nine other reports noted heavy loads dropped from forklifts that were near misses. For example, there was a series of forklift-related occurrences at Rocky Flats, culminating on May 3, 2000, in which five Pipe Overpack Components (POCs) were dropped, each weighing over 200 pounds. Although no one was injured, the contractor immediately ordered a sitewide stand-down on forklift operations. Corrective actions included developing a method to secure the POCs to forklifts and ensuring that all forklift operations have a job hazard analysis. (ORPS Report RFO--KHLL-TRANSOPS-2000-0004)

As another example, on August 8, 2000, a forklift operator at INEEL dropped a 600-pound load consisting of a wooden storage box containing a lead pig while attempting to move it from a storage rack nine feet high. The operator assumed the box was evenly loaded and lifted it at its center, but the load was off-center and the box fell. Corrective actions included labeling packages with off-center loads and training forklift operators to use caution in picking up unmarked objects. (ORPS Report ID--BBWI-SMC-2000-0007)

Two Operating Experience Weekly Summary articles written in 1999 (Nos. 99-17 and 99-23) also addressed heavy loads dropped from forklifts, one concerning an occurrence at Oak Ridge that injured two workers. In October 1996, the DOE Office of Oversight issued a *Special Study of Hoisting and Rigging Incidents within the Department of Energy* that indicated forklifts caused one-third of all hoisting and rigging incidents and 38 percent of all accidents.

Forklift operations continue to pose a significant risk to workers, particularly when heavy loads are not secured to the forklift before moving. Experience indicates that proper job hazard analysis and planning can reduce this risk.

KEYWORDS: *OSHA/industrial hygiene – injury; OSHA/industrial hygiene – near miss other*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls*

2. NEAR MISS OF EXOTHERMIC REACTION DUE TO LOSS OF AIR SUPPLY

On February 4, 2001, an electrical power outage at the Oak Ridge Y-12 Plant shut down supplies for the plant and instrument air. This led to a sequence of events that threatened the safety of a hydriding reaction in Building 9204-2. The loss of air supplies was not fully anticipated in the facility's design. Without a notification or alarm warning of the loss of air supplies, the facility operator was fortunate to promptly detect the loss and take the necessary actions to place the ongoing reaction into a safe condition. (ORPS Report ORO--BWXT-Y12SITE-2001-0007)

A hydriding operation was underway in Building 9204-2 when the electric power and air supplies were lost. A reactor furnace was nearing its peak operational temperature, as melted lithium metal inside was being fed deuterium to form lithium deuteride. The loss of instrument air pressure caused the reactor's deuterium supply valves to shut automatically. Subsequently, the molten lithium's absorption of the remaining gas in the reactor created a partial vacuum in the reactor vessel. The O-ring used to seal the reactor vessel was not rated for reactor temperatures, and depended upon plant air for cooling. Loss of plant air during this event threatened to breach the O-ring's integrity, and would have led to an inrush of room air into the vessel due to the partial vacuum. The molten lithium's sudden exposure to air could have caused a violent exothermic reaction or explosion.

In previous cases of failed plant and instrument air supplies, utilities personnel notified the Plant Shift Supervisor, who notified the Building 9204-2 shift supervisor. These notifications were necessary because the facility had no capability for monitoring the status of plant and instrument air pressures on a real-time basis. During this occurrence, utilities personnel were troubleshooting problems caused by the power outage and failed to provide a timely notification. The facility's shift supervisor, however, fortunately recognized the loss of air pressure from other events in the facility, and quickly placed the reactor into a safe condition by opening valves that fed argon into the vessel.

As a result of this occurrence, the contractor will install air flow meters and alarms for each reactor furnace. The contractor is now also considering the use of new high-temperature gaskets and a backup air supply.

A search of the ORPS reports for the past two years found six cases where loss of air supply impacted the operation of safety-grade equipment, mostly ventilation system controls. None of these occurrences, however, involved a loss of dual-safety functions (e.g., valve control and cooling), and so the occurrence at Building 9204-2 appears unique. Nevertheless, this occurrence demonstrates the need for users of plant and instrument air systems to fully determine and address failure modes and consequences involving the loss of air supply.

KEYWORDS: *Mechanical/structural – mechanical equipment, electrical – power outage, conduct of operations – safety system actuation, OSHA/industrial hygiene – near miss other*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazards Controls*

3. NEAR MISS FROM AMMONIUM NITRATE REACTION

On June 19, 2001, an experiment to extract uranium metal from uranium slag using ammonium nitrate resulted in a violent reaction inside a glovebox at the Y-12 Plant's Building 9202. The reaction caused a deposition of material on the glovebox window and breakage of the glass beaker in which uranium and ammonium nitrate had solidified overnight. The experimenter holding the beaker when the reaction occurred was unharmed; however, one of the glovebox gloves he was using had become imbedded with glass fragments, and the other received a small tear. (ORPS Report ORO--BWXT-Y12SITE-2001-0022)

The purpose of the experiment was to explore new ways to extract uranium metal from uranium oxide. The experiment first combined an oxide of depleted uranium with calcium to form a slag. The slag was ground into powder, and calcium oxide was then leached from it using an ammonium nitrate solution. The job scope on the work authorization form for the experiment discussed the use of filters to remove the uranium powder from the leaching solution. This was described in general terms, and not as a step-by-step procedure. A hazard evaluation attached to the work authorization form noted that ammonium nitrate is explosive, but no explicit limits or controls were established. The experimenter failed to review the work authorization package before undertaking the experiment.

Because the filtration process was very slow, the experimenter decided instead to extract the uranium by twice mixing slurries of slag and ammonium nitrate solution, and then decanting the solution and the dissolved calcium oxide. He omitted the water-rinsing steps mentioned on the work authorization form. The final product consisted of 35 grams of depleted uranium and less than 1 gram of ammonium nitrate. The experimenter stored the still-wet final product material overnight in a 250-ml glass beaker in the interlock of the glovebox.

The next day, June 19, 2001, the experimenter transferred the beaker to a glovebox inerted with argon, and found the product had solidified and caked on the bottom of the beaker. Holding the beaker in his left hand, he attempted to loosen small amounts of the material with a stainless steel spatula. After a few minutes of scraping, the ammonium nitrate reacted violently with the uranium. The reaction produced a flash of light and a loud noise, and filled the glovebox with smoke. It deposited material on the glovebox window and broke the glass beaker held by the experimenter. The experimenter immediately pulled his hands free of the glovebox and was unharmed. Glass fragments were found in the left glove, and a one-inch slit was cut in the right glove. Surveys found no significant radiological contamination on the experimenter, the glovebox, or in the immediate area.

The contractor suspended all hands-on laboratory work pending review and revision of job hazard analyses, work authorization forms, and safety documentation. The contractor will also review the work authorization process. A management critique of this occurrence noted the following probable causes:

- A different technique was used to perform this experiment than had previously been described during the work authorization process.
- The experimenter failed to recognize the introduction of a hazard that had been analyzed but not recognized to be present in this configuration.
- The safety reviews identified the explosive hazard, but failed to control the hazard.
- The experimenter was not familiar with the work authorization package and had not participated in its development.
- Supervision failed to ensure that all personnel working to the documented scope of work were familiar with the hazards, and that controls were in place.

A search for similar occurrences in the ORPS database found another event involving an ammonium nitrate reaction in a glovebox. On June 25, 1999, workers at the Los Alamos National Laboratory's Chemistry and Metallurgy Research Facility were using hotplates in two gloveboxes to evaporate three trays of technetium-99 (Tc-99)-contaminated solutions. When they left for a lunch break, high levels of ammonium nitrate in the solutions reacted violently with trace amounts of metal. This reaction over-pressurized one of the gloveboxes, rupturing a glove and spreading Tc-99 contamination throughout the room. Since no one was in the room, there were no personnel injuries or exposures. The lessons learned from this occurrence included the need to perform work within an established review and approval process, and for senior management to review work authorizations. (ORPS Report ALO-LA-LANL-CMR-1999-0020)

At this time, corrective actions and lessons learned have yet to be finalized in an updated or final ORPS report on the Y-12 Plant ammonium nitrate reaction. However, the occurrence obviously demonstrates the importance of identifying hazards and controls for one-of-a-kind experiments, and ensuring that all those performing such work are familiar with the job scope described in the job hazard analysis and work authorization documents.

KEYWORDS: *Conduct of operations – safety analysis/USQs, inadequate procedure, inadequate job planning other, OSHA/industrial hygiene – near miss other, other – glovebox*

ISM CORE FUNCTIONS: *Develop and Implement Hazards Controls, Perform Work Within Controls*

4. TUBE BUNDLE REACTION LEADS TO PRICE-ANDERSON ACTION

On March 19, 2001, DOE issued a Preliminary Notice of Violation (PNOV) and a proposed civil penalty of $41,250 against BNFL, Inc., the contractor conducting decontamination and decommissioning activities at the East Tennessee Technology Park in Oak Ridge, Tennessee. The DOE action is a result of quality assurance deficiencies associated with an unanticipated chemical reaction that occurred in a T-4 converter tube bundle during disassembly activities on April 4, 2000 in Building K-33. (ORPS Report ORO--BNFL-K32-2000-0001)

On April 4, 2000, an unanticipated chemical reaction developed in the tube bundle of a converter while workers were using a plasma torch to cut the converter tube sheets. The T-4 converters were modified in the 1980s, and the workers were unprepared for an internal configuration different from that encountered in previously used converters. Because of the different configuration, the tooling developed for the job was ineffective, and several attempted mechanical cutting techniques were unsuccessful. The Group Manager subsequently initiated a Field Change Notice (FCN) to the work plan, which allowed the use of a plasma arc cutter. The Fire Protection Engineer advised the Group Manager to have Class D fire extinguishing equipment available. Initial attempts to cut the tube sheet proceeded without incident. However, a subsequent cutting attempt resulted in the initiation of a chemical reaction near the center of the tube sheet. Workers had observed similar appearing reactions previously, and their experience was that the reaction was self-extinguishing. In this case, however, the reaction did not self-extinguish, and the workers used at least one Class D fire extinguisher with little effect. The fire department was summoned and, upon learning that a metal reaction was occurring, requested that metal fire extinguishing agents be brought to the scene from Y-12 and from the Oak Ridge National Laboratory. Two firefighting entries were made; the first to extinguish the bulk of the combustion materials, and the second to search for and extinguish embers in the debris. There were no worker exposures or releases of uranium to the environment.

The hazards associated with this work were not properly identified. The Group Manager had the procedural authority to issue the FCN allowing the use of a plasma arc cutter, and to determine if any additional review by a subject matter expert (SME) was needed. The project's procedural process required SME review only in the event of “intent” changes that are defined only for safety-significant systems. Because this work did not involve a safety-significant system, the Group Manager determined that the additional SME review was not required. BNFL has subsequently developed a procedural process requiring involvement of SMEs and including a broader definition of “intent” changes. Additionally, although the workers had received general fire watch training, primarily with Class A, B, and C extinguishers, the Class D training was peripheral in nature, and not hands-on. The discharge from a Class D extinguisher exhibits more of a squirting than a streaming effect. It is unclear whether, if the workers had been properly trained in the use of Class D extinguishers, the chemical reaction could have been quickly extinguished.

DOE notified BNFL of the preliminary determination of violations and proposed civil penalty in a letter dated March 19, 2001. This letter enclosed the PNOV that described violations involving (1) failure to comprehensively identify the hazards associated with the T-4 converter decontamination and decommissioning, (2) failure to follow established procedures, and (3) failure to identify and mitigate known operational deficiencies despite several opportunities to do so. Additionally, DOE expressed concern that BNFL, Inc. had failed to adequately address hazards analysis and work control issues that were identified from several incidents (e.g., portable High Efficiency Particulate Air filter fire, respirator cartridge ignition) that occurred during the two years preceding the April 4, 2000 event.

These violations were classified as Severity Level II and III violations (See Section VI of Appendix A, General Statement of Enforcement Policy, to 10 CFR Part 820 for a definition of Severity Levels). In determining the Severity Level of these violations, DOE considered the actual and potential safety significance associated with the event under consideration, the programmatic and recurring nature of the problems, and other factors. DOE determined that no mitigation was warranted for timely self-identification and reporting, because the chemical reaction was a self-disclosing event. DOE also evaluated the adequacy of corrective actions identified and implemented by BNFL and concluded that corrective actions taken through March 2001 appeared to address the issues that led directly to the chemical reaction, and that a 25% mitigation of the maximum Severity Level II civil penalty for violations of 10 CFR 830.122(c) was appropriate. All corrective actions associated with the Non-Compliance Tracking System are now closed, with the exception of verification (scheduled for August 2001) and validation (scheduled for December 2001). DOE remains concerned with the long-term effectiveness of the corrective actions aimed at enhancing worker awareness of nuclear safety-related issues, and will be closely evaluating corrective action effectiveness.

BNFL was required to respond within 30 days to the PNOV to document specific actions taken or planned to prevent recurrence. BNFL paid the fine of $41,250 effective April 18, 2001, resulting in the conversion of the PNOV to a Final Notice of Violation (FNOV).

The Price-Anderson Amendments Act of 1988 requires the Energy Department to undertake regulatory enforcement actions against contractors for violations of its nuclear safety requirements. The program is implemented by the Office of Enforcement and Investigations. This action was taken with the support and participation of the Department's Oak Ridge Operations Office, which will ensure that the corrective actions are fully implemented. Additional details can be found on the Internet at http://tis.eh.doe.gov/enforce.

KEYWORDS: *Work planning, enforcement, Price Anderson Amendments Act*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Provide Feedback and Continuous Improvement*

5. INADEQUATE VERIFICATION OF VALVE CLOSURE CAUSES SAFETY CONCERNS

On March 12, 2001, at Savannah River, a chain-operated manual valve, presumed closed by the operator, was left in a partially open position, resulting in the transfer of process water to an incorrect tank. Although the valve lineup was performed according to procedure and independently verified, the process water was transferred into tank 11.2, which was empty at the time, rather than the intended vessel, 13.1. The reason for the valve remaining partially open is surmised to be lack of lubrication. Although the valve lineup was performed in accordance with established procedures and independently verified, the inability of operators to positively verify that the valve was completely closed, as well as the lack of a formal preventive maintenance program, could have placed the facility in a potentially unsafe configuration. (ORPS Report SR--SRWC-FCAN-2001-0012)

While adjusting the First Cycle Feed, Operations personnel determined that 25,000 pounds of process water (slightly acidified domestic water) needed to be transferred from vessel 11B to vessel 13.1. Since the capacity of vessel 11B is only 3,665 pounds, the transfer had to be accomplished with six full tank volumes and a part of a seventh. A pre-job briefing was held in the control room with a control room operator and the First Cycle Supervisor (FCS). Because the tank 11B outlet piping header is common to several vessels, the chain-operated inlet valve is required to be in closed position while transferring from tank 11B to tank 13.1.

The Building Patrol Operator (BPO) performed the valve lineup in accordance with the approved procedure for valving tank 11B, and the valve lineup was independently verified by a second BPO. Verification of valve closure on a chain-operated valve is done by pulling on the chain to ensure that resistance is felt, and both the BPO and the independent verifier did this. The valve stem position, another indicator of the valve position, is partially hidden from the operator's view.

As the fourth tank volume of process water was in progress, the FCS noticed that the liquid level in tank 13.1 was not rising. He then observed that tank 11.2, previously empty, had a rising water level. The facility could have been placed in an unsafe condition if tank 11.2 had contained a critical mass and enough process water to dilute the acidity below minimum limits. The FCS realized that the water from the head tank was flowing into the wrong vessel, and immediately terminated the transfer by closing the automatic outlet valve on the head tank.

After the discovery of process water in tank 11.2, the Building Supervisor went to check the valve lineup where tank 11B conveys liquid into a header that feeds several tanks, including tanks 11.2 and 13.1. This check indicated the valve alignment to be correct. The BPOs who performed the initial valve lineup and verification correctly verified the position of the inlet valve to tank 11.2 by manipulating the manual chain-operated valve in the closed direction. Feeling resistance in the closed direction, each operator assumed the valve to be closed. A further attempt to manipulate the valve in the closed direction by using additional force resulted in the valve being freed and traveling to the closed position.

The direct and root causes of this transfer of process water to the wrong tank were an equipment or material problem with a defective or failed part. While the valve appeared closed to the BPO and the independent verifier, it was, in fact, stuck partially open. The contributing cause was personnel error, inattention to detail, as the BPOs were not able to positively verify that the valve was closed, and the operator was not closely monitoring the liquid level of the receiving tank.

Several corrective actions have been taken. The first action taken was for Operations to develop and implement a schedule for preventive maintenance of chain-operated valves, including lubrication. Operations was also directed to issue a Facility Operating Experience Program (FOEP) Lessons Learned from the event to emphasize proper transfer protocol, including identifying potential and inadvertent routes, verifying the receipt of material, and monitoring liquid level increases in the receiving tank. The FOEP is to include a Standing Order for proper transfer protocol as an attachment. Operations is to follow up the transfer protocol oral assessment with training of all personnel in identified areas of weakness. Facility management will administer a remediation program to the individual involved. Management will also meet with the involved personnel and clearly reinforce expected roles and responsibilities.

EH has identified a number of similar occurrences in which inadvertent transfers of material resulted from misaligned valves or valves presumed to be closed. The following is an example.

On July 19, 1999, at the Savannah River Site, Operations personnel were attempting to transfer process water from the 16D head tank to the 16.3 vessel. Prior to the start of transfer operations, the BPO moved the valve to the closed position and pulled on the chain until it felt tight. Another BPO independently verified the valve position in the same manner. As the transfer began, the Control Room Supervisor noticed that the liquid level in vessel 17.5 was rising instead of in 16.3, and immediately halted the transfer. A further investigation of the event revealed that the valve had not been manipulated from its normally open position in several years, causing the chain operator to bind. (ORPS Report SR--WSRC-FCAN-1999-0017)

These events illustrate the importance of operators being able to positively verify valve closure rather than relying upon supposition or experience. A properly managed, formal preventive maintenance program for safety-related chain-operated valves is essential to ensure safe operations. Management must evaluate any training deficiencies in personnel involved in material transfers, and follow up with training in areas of identified weaknesses.

DOE-STD-1040-93, Change 1, *Guide to Good Practices for Control of On-Shift Training,* provides guidance on the use of hands-on training to develop a core of skilled personnel able to perform criticality-significant operations. DOE-STD-1052-93, *Guideline to Good Practices for Types of Maintenance*

Activities at DOE Nuclear Facilities, contains information on developing an effective preventive maintenance program at DOE facilities. These standards are accessible on the Internet at http://tis.eh.doe.gov/techstds/standard/appframe.html.

KEYWORDS: *Preventive maintenance, inadvertent transfer, chain-operated valve*

ISM CORE FUNCTIONS: *Define the Scope of Work, Analyze Hazards, Develop and Implement Hazard Controls*

6. INADEQUATE PRE-JOB BRIEFING CAUSES CRITICALITY CONCERNS

On March 14, 2001, at Savannah River, Solid Waste Rigging Personnel moved a metal container from transuranic (TRU) Pad 3 to TRU Pad 7. The next day, during an inspection tour of TRU Pad 7, the TRU Shift Manager noticed that the container was placed approximately 16 inches from one of the black metal FB-Line containers instead of the three feet minimum spacing required for nuclear criticality safety. This inadvertent violation of a nuclear criticality control and Technical Safety Requirement placed the facility in an unsafe configuration. (ORPS Report SR--WSRC-SLDHZD-2001-0004)

TRU Pad 7 holds five black metal containers for storing TRU fissile waste, and the containers are separated from each other by a minimum 3' spacing in accordance with Nuclear Criticality Safety Control (NCSC) requirements. On March 14, 2001, a crew comprised of one labeling person, one procedure person, and two Rigging and Heavy Equipment (R&HE) personnel began relocating containers from TRU Pad 3 to Pad 7. Shortly thereafter, one of the R&HE riggers left to support an incoming TRU shipment. This particular R&HE operator was the designated "spotter" to direct the other rigger in moving the TRU container and locating it at the proper separation distance from the other containers. After moving the box, the lone rigger went to TRU Pad 7 to ensure its proper placement, but overlooked the fact that the container was placed closer than three feet to one of the black metal containers.

The pre-job briefing did not define the responsibilities of the spotter during the TRU waste movement. The importance of the spotter's role at TRU Pad 7 during container placement operations was not properly emphasized, nor were the associated criticality issues addressed. The posting for the 3' minimum spacing requirement was not prominently displayed on the containers. The rigger could not read the labels while adjusting the position of the moved container on TRU Pad 7.

TRU Pad 7 was immediately placed into standby mode, and radiological control personnel checked the containers to ensure that no elevated neutron levels existed. In addition, a number of other corrective actions were undertaken. The procedure and related operator aids have been revised to incorporate Criticality Safety Limit (CSL) controls and to adequately define the roles and responsibilities of the personnel involved with respect to spotters and placement of containers. The facility's other operations and procedures requiring NCSC controls were reviewed to ensure that appropriate CSL safeguards are implemented. Physical boundaries of three feet have been re-established around the black metal containers on TRU Pad 7, and the FB-Line black metal boxes have been relabeled on all four sides with larger, more visible letters. An engineering evaluation of criticality controls for TRU Pad 7 has been completed, and design controls (physical barriers) initiated for NCSC areas, as required. Facility management has examined the need for additional NCSC physical boundary measures at other waste storage or disposal areas.

This event illustrates the importance of adequate procedures, procedure compliance, and attention to detail. Lessons learned from this event will be incorporated into the Solid Waste Management Facility criticality training program.

Events similar to this have occurred, and the following is a pertinent example. On November 26, 1999, at Savannah River FB-Line, a Nuclear Safety Specialist identified two TRU waste pails that were not spaced 3' apart, as required by the Nuclear Safety Control (NSC) for fissile items stored in temporary storage restraints. (ORPS Report SR--WSRC-FBLINE-1999-0036) The operator responsible for temporarily storing a TRU waste pail placed it within the boundaries of red "Fissile" tape left behind from a previously stored item, but failed to measure the spacing between the pail and other waste items to ensure compliance with NSC requirements. Because the NSC spacing requirement is more conservative than the Nuclear Criticality Safety Supplement limit of 24 inches, facility personnel confirmed that no CSLs were exceeded in this occurrence, and facility safety was not compromised.

Such occurrences demonstrate the importance of strict adherence to nuclear criticality controls to ensure safe operations at DOE facilities. Both mass and space restrictions must be followed to prevent violation of a nuclear criticality control parameter, which could lead to an inadvertent nuclear criticality event. Occurrences such as these also strongly underscore the fact that physical controls such as mass and spacing requirements are far preferable to administrative controls in achieving criticality safety.

DOE Order 420.1, *Facility Safety*, provides guidance on nuclear criticality safety program requirements for DOE facilities, and lists the American Nuclear Society's ANSI/ANS standards that provide the basis for nuclear criticality safety programs. Specifically, ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety,* provides the elements of an acceptable nuclear criticality safety program for operations outside of reactors. ANSI/ANS-8.20, *Nuclear Criticality Safety Training*, provides the criteria for administering a nuclear criticality safety training program for personnel who manage, work in or near facilities, or work outside of reactors, where the potential exists for nuclear criticality accidents. DOE Order 420.1 is available at http://tis.eh.doe.gov/techstds/standard/appframe.html.

KEYWORDS: *Transuranic, criticality safety limit*

ISM CORE FUNCTIONS: *Develop and Implement Hazard Controls, Perform Work within Controls*